

Temperature Use Efficiency and Yield of Groundnut Varieties in Response to Sowing Dates and Fertility Levels in western dry zone of India.

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Abstract

A field experiment was conducted in loamy sand soil during *kharif* season of 2009 and 2010 to evaluate the temperature use efficiency and yield of groundnut varieties in response sowing dates and fertility levels. The treatments consisted of four sowing dates (20 April, 15 May, 9 June and 4 July) and two varieties of groundnut (HNG 10 and TG 37A) as main-plot treatments and four fertility levels of nitrogen and phosphorus application (0, 20 N-40 P₂O₅, 30-60 P₂O₅ and 40 N-80 P₂O₅ kg ha⁻¹) as sub-plot making a total of 32 treatment combinations. The experiment was laid out in split-plot design with three replications and crop growth rate, yield parameters, harvest index and temperature use efficiency were recorded on crop. The results showed that significantly higher CGR at 30-60 and 60-90 DAS was observed in HNG 10 variety. Further delays in sowing from 9 June significantly reduce crop growth rate. However, the growth rate of TG 37A variety was observed to be statistically at par among the sowing dates. In HNG 10 variety higher pod, kernel, haulm and biological yield were observed at par to each other from 20 April to 9 June sowing. Maximum heat unit efficiency was observed on 9 June sowing date while the highest yields were recorded in TG 37A variety with 4 July sowing. Harvest index in both the varieties was observed to be significantly higher in 4 July sowing date. All the fertility treatments produced significantly higher crop growth rate and yields than the treatments receiving no Fertilizer application. Application of 30 kg N-60 kg P₂O₅ ha⁻¹ significantly enhanced the crop growth and yield over 20 kg N-40 kg P₂O₅ ha⁻¹ but at par with 40 kg N-80 kg P₂O₅ ha⁻¹. However, the crop uses maximum temperature in the month of June for better growth and yield. Thus, it could be

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concluded that the suitable sowing date of HNG 10 and TG 37A varieties in western dry zone of India are around 9 June and 4 July respectively. Application of 30 kg N-60 kg P_2O_5 ha⁻¹ was optimum for growth and yield of the crop.

Key words Crop growth, Sowing dates, Fertility levels, Heat unit, Yields

INTRODUCTION

Groundnut is an important oil crop in India. During 2011-2012, India could produce groundnut of 6.94 mt [1]. In dry agricultural area, farmers have limited time for crop sowing, but in regular irrigation is one of the most important non-monetary inputs affecting yield of crops. Sowing time of groundnut is well documented in other regions [14]. In Bikaner region, groundnut sows is under irrigated conditions. It started two decades ago in the command area of Indra Gandhi Nahar Pariyojana (IGNP) and later on it spread to tube well irrigated area of the region. At that time, dust storms were common in the region with minimum vegetation during optimum sowing time of May and June months leading to poor crop establishment due to which the farmers started sowing of groundnut in early summer of April and May for better crop establishment with its harvesting in between October to November. In western dry zone of India some workers [13] reported application of 60 kg N/ha along with equal level of phosphorus as the appropriate fertilizer level while others recommended 20 kg N and 32 kg P_2O_5 ha⁻¹ for groundnut. Due to the variation in the optimum fertilizer requirement for groundnut reported by research workers it has also become necessary to determine fertilizer requirement for the crop varieties of different maturity under different sowing dates. This research was conducted using two varieties of groundnut to find suitable sowing dates and fertilizer levels on growth and yield of groundnut in dry western zone of India.

Materials and Methods

Experimental Site: The experiment was conducted during *kharif* season of 2009 and 2010 at Agronomy Research Farm, College of Agriculture, Bikaner (Rajasthan) under hyper arid

53 condition, which is situated at a 28° 01'N latitude and 73 ° 22' E longitudes at an altitude of
54 234.70 meters above mean sea level (*Arabian Sea*).

55 **Soil:** The soil of the experimental site was loamy sand and having 156.33 kg ha⁻¹ alkaline
56 permanganate oxidizable N[17], 16.05 kg ha⁻¹ available P [12], 221.0 kg ha⁻¹ 1 N ammonium
57 acetate exchangeable K [16] and 0.80% organic carbon [8] The pH of soil was 8.4 (1:2.5 soil and
58 water ratio). Field capacity, permanent wilting point and bulk density recorded were 8.4.0% (w/w),
59 1.1.83% (w/w) and 1.66 Mg m⁻³, respectively in 0-30 cm soil depth.

60 **Temperature:** On daily basis maximum and minimum daily air temperature data were recorded
61 from Agro meteorological observatory, Agricultural Research Station, Bikaner. Temperature at
62 which there is no growth which is also called base temperature, it is taken as 10°C [10] for
63 groundnut growth and calculated temperature use efficiency. Interaction effect was observed in
64 different sowing dates and varieties on use of temperatures. The temperature use efficiency went
65 on increasing from vegetative growth to pod filling and physiological maturity of the crop
66 Nuttonson [11].

67 **Cultural practices:** The seed treated with chloropyriphos at the rate of 2.5 ml/kg before sowing,
68 HNG 10 and TG 37A were sown at the seed rate of 80 kg, 70 kg/ha, respectively. Row spacing of
69 HNG 10 and TG 37A was 25 cm and 30 cm with 5 cm depth. Nitrogen and phosphorus were
70 applied as per treatment using urea (46% N) and SSP 16% P₂O₅ as nutrient sources. The fertilizers
71 were applied as basal application in the furrows just before sowing at a depth of 8-10 cm by
72 “*pora*” method. Gap filling and thinning was also done at appropriate stage. In addition to rainfall
73 received during the both cropping seasons average 22.5, 19.5, 16.5 and 12.5 irrigations in HNG 10
74 and 16.5, 14.5, 13.4 and 11.5 life saving irrigations in TG 37A were given in 20 April, 15 May, 9
75 June and 4 July sowing respectively, irrigation through sprinkler system from time to time to
76 ensure optimum growth, development and yield of groundnut. Hand weeding was done manually
77 with the help of hand hoe to keep the field weed free. At the time of second weeding earthing up
78 along the rows was also done for improvement in pegging. Groundnut was grown as per
79 recommended practices and was harvested as per days to maturity both the years of

80 experimentation. The crop was harvested manually by uprooting the whole plant when leaf veins
81 started yellowing and about more than 90 per cent pods became fully mature. The plants from each
82 net plot were harvested separately and stacked plot wise for sun drying and subsequent threshing.
83 **Statistics:** The experiment was laid out in split-plot design with three replications, assigning 32
84 treatments consisting of four sowing dates (20 April, 15 May, 9 June and 4 July) and two varieties
85 (HNG 10 and TG 37A) as main plot treatments and four fertility levels of nitrogen and phosphorus
86 application (0, 20 N: 40 P₂O₅, 30 N: 60 P₂O₅ and 40 N: 80 P₂O₅ kg ha⁻¹) as sub-plots and crop
87 growth rate, yield parameters, harvest index and temperature use efficiency were recorded on crop.
88 All the data obtained from groundnut for two consecutive years of trails were statistically analyzed
89 using the *F*-test [5] Critical difference (CD) values at *P*=0.05 were used for determine the
90 significance of differences during mean values of treatments.

91 **Results and Discussion**

92 ***Crop and weather***

93 Maximum rainfall of 51.50 mm and 21.00 mm were recorded in July of 2009 and August 2010,
94 respectively (Table 1). Highest temperature was observed in of May of both the years. Growth of
95 groundnut was affected by different uncontrollable environmental conditions. Interaction effect
96 was observed in different sowing dates and varieties on thermal temperatures. The heat unit
97 efficiency went on increasing from vegetative growth to pod filling and physiological maturity of
98 the crop. Among the different sowing dates, heat unit efficiency was found to be higher in 9 June
99 than all other three sowing dates (Fig.1). Significantly higher heat unite efficiency was observed in
100 HNG 10 variety. compared with TG 37A variety HNG 10 variety used most heat units to reach
101 maturity in vegetative growth [9]. These results are also enclose agreement with the findings [6].

102 ***Temperature use efficiency***

103 Efficiency of utilization of temperature in terms of dry matter accumulation depends on crop type,
104 genetic factors and sowing. Duration of crop phenophases is an essential component of weather
105 based dynamic crop growth rate and yield simulation models. Crop phenology can be used to
106 specify the most appropriate sowing date of specific development process. The duration of each

phenophase determines the accumulation and partitioning of dry matter in different organs reported that the duration of a particular crop growth stages was directly related to temperature and this duration of particular species could be predicted using the sum of daily air temperature [9].

Crop growth rate

Results showed that of tested varieties in the study, in HNG 10 variety higher crop growth rate was observed than TG 37A variety (Fig. 2), primarily due to the differences in the genetic constitution and growth habit of these varieties as evidenced from the similar variation in crop growth rate of these varieties. The variable behaviour of these varieties could be explained in genetic constitution and variation in growth habit of these varieties the similar interaction effect recorded on heat unit efficiency of these varieties. HNG 10 variety is semi-spreading variety which seems to have indeterminate growth habit the considerable. This variety sown early was exposed to longer duration for vegetative growth due to its indeterminate growth habit. On the other hand, the variety sown on later dates was exposed to shorter duration for vegetative growth and there for recorded less crop growth at these dates. In contrast, the TG 37A variety was a Spanish bunch type and probably seems to be a variety of short duration maturity and determinate growth habit. Thus, the variation in growth parameters of the two varieties with variation in sowing dates resulted due to interaction between genetic constitution of the varieties and growth factors like manures, fertilizers, moisture availability *vis-a-vis* environmental factor like temperature, day length, relative humidity, rainfall, wind velocity and biotic and abiotic factors which have a considerable bearing on important plant functions such as photosynthesis, respiration, transpiration, nutrient and water absorption *etc.* [15]

Yields

HNG 10 variety was recorded higher and almost similar pod and kernel yields under the first three sowing dates beginning from 20 April to 9 June (Table 3). Delayed sowing of this variety beyond 9 June on 4 July resulted in significant reduction in these yields. On the contrary, yield of TG 37A variety progressively increased under later dates of sowing with the highest yields recorded under the last sowing date of 4 July. Since this is a short duration variety of determinate growth habit, it

recorded the highest yields in the last date of sowing as this sowing date provided optimum maturity period requirement to this variety. The early sowing dates provided very longer than optimum periods and harsh environments to this variety of determinate growth habit, these dates recorded significantly lower yields. Since the pod and kernel yields are cumulative function of the yield attributes, the variation in pod and kernel yields of these varieties as affected by sowing dates. These results are also in close agreement with the findings of [3,7].

Sowing dates also had significant interaction effects with crop varieties on haulm and biological yields of groundnut (Table 3). The HNG 10 variety was recorded the highest haulm and biological yields when planted on the earliest sowing date of 20 April. Sowing of this variety on latter dates resulted in significant reduction with each delay in sowing with the lowest haulm yield of 46.74 q ha⁻¹ and biological yield of 81.18 q ha⁻¹. This could be explained due to the similar variation in the maturity periods made available to this variety for overall growth. Thus the variation in the haulm yield recorded under different dates of sowing with the minimum haulm yield recorded in last date of sowing. The variety HNG 10 also recorded almost similar variation in biological yield as that observed in haulm yield due to the effect of sowing dates. Since biological yield was a cumulative function of haulm and pod yields, the variation in biological yield with sowing dates could be mainly attributed to the haulm yield with minor contribution from the pod yield, as the pod yield of this variety was almost similar in the three initial dates with reduction only under the last date of sowing. Similarly TG 37A variety was recorded significant reduction in haulm yield with every delay in sowing but the reduction was found to be considerably lower than that recorded in HNG 10 variety due to probably to its determinate growth habit. This type of growth habit did not allow the variety to widen the variation in haulm yield with variation in maturity periods as affected by sowing dates. In contrast to haulm yield, the TG 37A variety was recorded a reverse trend in pod yield as affected by sowing dates with the lowest yield recorded under the first date of 20 April sowing and the highest yield recorded under the last date of 4 July sowing. Since the biological yield is a cumulative function of haulm and pod yields, TG 37A variety was recorded almost

similar biological yields with minor variations under various sowing dates due to certainly to opposing trends in haulm and pod yields recorded as affected by sowing dates. Thus, the cumulative effect of the variation in growth and yield attributes of the two varieties recorded with variation in sowing dates resulted variation in various yields of groundnut namely pod, kernel, oil, haulm and biological yields as a result of interaction effect between genetic constitution of the varieties and environmental factors, These results was also in close agreement with the findings [4].

Effect of fertility levels

Application of nitrogen and phosphorus up to 30 kg N-60 kg P₂O₅ ha⁻¹ was recorded higher pod yield, kernel yield, haulm yield and biological yield (Table 2) over control and 20 kg N-40 kg P₂O₅ ha⁻¹. Further increase in the fertility level up 40 kg N-80 kg P₂O₅ ha⁻¹ was statistically at par with 30 kg N-60 kg P₂O₅ ha⁻¹. Early and plentiful availability of nitrogen and phosphorus to plants favourably influenced the kernel development and kernel size, which ultimately resulted in, increased pod and seed index and shelling percentage. Improved overall growth and profuse branching due to nitrogen and phosphorus fertilization led to increased net photosynthesis on one hand and greater mobilization of photosynthates with suitable temperature requirement towards reproductive structures on the other might have increased the yield attributes significantly result was agreement with those of [2].

Conclusion

The present study indicates that suitable sowing date for HNG 10 variety to be around 9 June and TG 37A variety for 4 July and recommended fertilizing dose 30 kg N-60 kg P₂O₅ ha⁻¹ for better growth and higher productivity of groundnut in western dry zone of India. However, groundnut crop use maximum temperature in June moth for better growth of HNG 10. These provide very clear picture of the amount, pattern and efficiency of heat energy consumption of the crops. These

184 can also be used very effectively for forecasting the occurrence of different phenophases of the
185 crops.

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Table 1 Temperature and rainfall data during growing seasons of groundnut (2009-2010)

Months	Temperature (°C)				Rainfall			
	Maximum	Minimum	Maximum	Minimum	Total Rainfall (mm)	Rainy days	Total Rainfall (mm)	Rainy days
	2009	2009	2010	2010	2009	2009	2010	2010
April	39.70	24.65	42.15	28.25	0.00	0.00	0.00	0.00
May	43.75	28.95	43.00	28.63	0.50	0.00	0.88	0.25
June	41.58	27.26	41.12	29.44	11.42	0.80	15.10	0.60
July	38.38	27.23	38.18	29.40	51.50	2.00	19.33	0.75
August	37.78	28.32	36.30	27.44	9.00	0.60	21.00	1.40
September	38.90	25.65	34.95	24.50	4.45	0.75	27.00	0.50
October	36.50	22.40	36.35	22.48	0.00	0.00	0.00	0.00
November	33.70	17.85	31.80	16.30	0.00	0.00	0.00	0.00
Monthly average	38.79	25.29	37.98	25.81	9.61	0.52	10.41	0.44

Table 2 Effect of different sowing dates and fertility levels on yields and harvest index of groundnut (Pooled data of 2 years)

Treatment	Pod yield (q ha⁻¹)	Kernel yield (q ha⁻¹)	Haulm yield (q ha⁻¹)	Biological yield (q ha⁻¹)	Harvest index (%)
Sowing date					
20 April	29.71	18.91	62.27	91.98	32.53
15 May	30.84	19.62	53.32	84.16	38.00
09 June	32.31	21.00	49.42	81.73	40.86
04 July	33.44	21.25	40.90	74.34	45.53
CD (<i>P</i> =0.05)	1.62	1.07	1.81	1.93	1.57
Varieties					
HNG 10	36.87	23.27	63.26	100.13	37.64
TG 37A	26.28	17.12	39.69	65.97	40.82
CD (<i>P</i> =0.05)	1.15	0.76	1.28	1.36	1.11
Fertility levels					
Control	28.04	17.42	47.11	75.15	38.35
20kgN-40 kg P ₂ O ₅ /ha	32.00	20.35	50.00	82.00	40.22
30kgN-60 kg P ₂ O ₅ /ha	33.53	21.70	53.65	87.18	39.78
40kgN-80 kg P ₂ O ₅ /ha	32.74	21.31	55.15	87.89	38.57
CD (<i>P</i> =0.05)	1.05	0.70	1.58	1.91	1.14

Table 3 Interaction effect of different sowing dates and varieties on yields of groundnut (Pooled data of 2 years)

Treatment	Pod yield (q ha ⁻¹)			Kernel yield (q ha ⁻¹)			Haulm yield (q ha ⁻¹)			Biological yield (q ha ⁻¹)			Harvest index (%)		
	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean	HNG 10	TG 37A	Mean
sowing date															
20 April	37.73	21.70	29.71	23.65	14.16	18.91	78.30	46.23	62.27	116.03	67.93	91.98	32.60	32.45	32.53
15 May	37.43	24.26	30.84	23.46	15.78	19.62	65.63	41.01	53.32	103.05	65.27	84.16	37.02	38.99	38.00
09 June	37.89	26.73	32.31	24.44	17.56	21.00	62.38	36.46	49.42	100.27	63.19	81.73	38.61	43.12	40.86
04 July	34.44	32.44	33.44	21.51	20.99	21.25	46.74	35.06	40.90	81.18	67.51	74.34	42.33	48.73	45.53
Mean	36.87	26.28		23.27	17.12		63.26	39.69		100.13	65.97		37.64	40.82	
CD (<i>P</i> =0.05)		2.30		1.52			2.56			2.73			2.22		

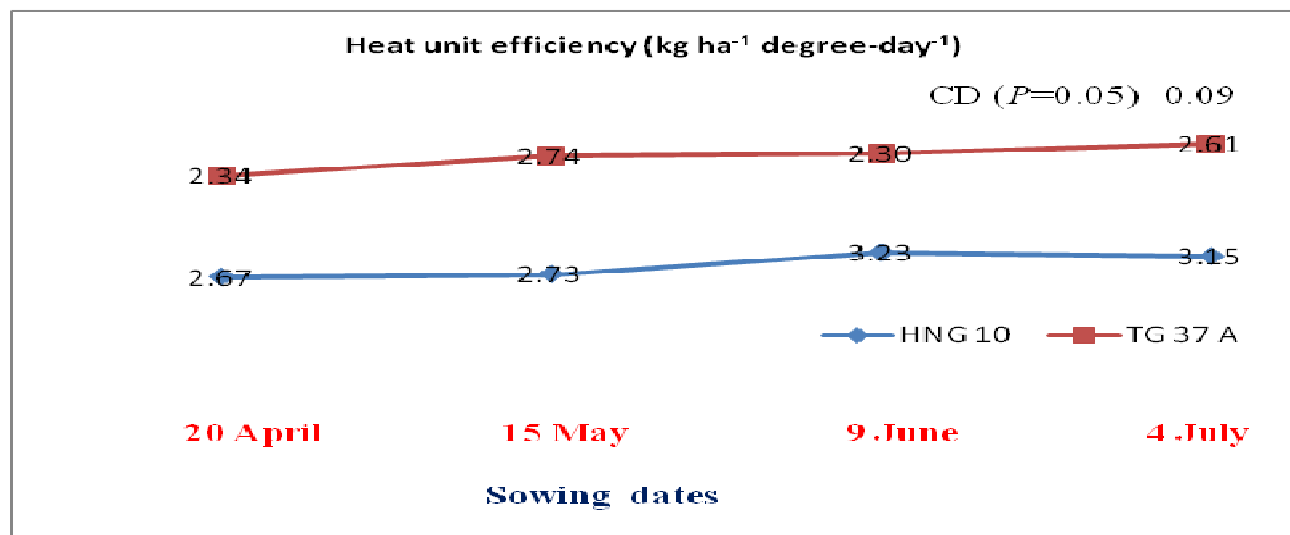


Fig. 1 Effect of sowing dates on heat unit efficiency of groundnut (Pooled data of 2 years)

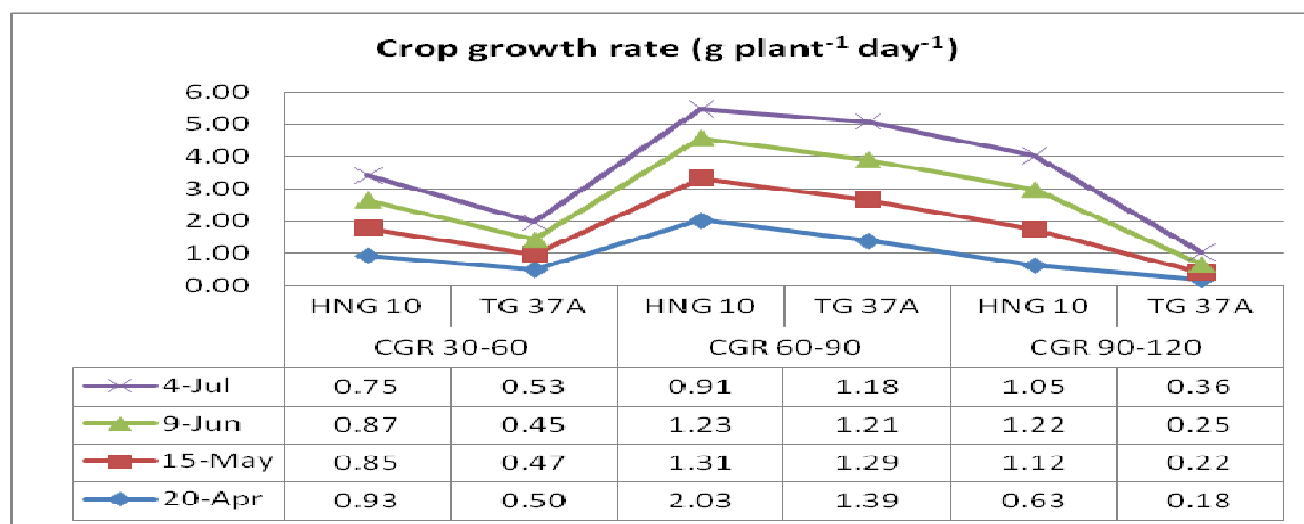


Fig. 2 Effect of sowing dates on crop growth rate of groundnut (Pooled data of 2 years)